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WONDER LAKE, McHENRY COUNTY, ILLINOIS

Pacific Northwest Environmental
Research Laboratory

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16. Abstracts

Annual total phosphorus and total nitrogen loadings to the lake were estimated and subdivided according to either point or non-point source origin. An assessment of the lake's trophic condition and limiting nutrient is also provided. All data collected by the U.S.E.P.A. National Eutrophication Survey during the one year study of the lake and its tributaries are included in the report.

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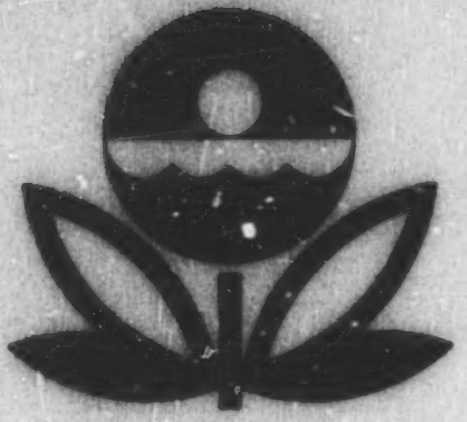

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REPORT
ON
WONDER LAKE,
McHENRY COUNTY,
ILLINOIS.

EPA REGION V

WORKING PAPER No. 322

WITH THE COOPERATION OF THE

ILLINOIS ENVIRONMENTAL PROTECTION AGENCY

AND THE

ILLINOIS NATIONAL GUARD

JUNE, 1975

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FOREWORD

The National Eutrophication Survey was initiated in 1972 in response to an Administration commitment to investigate the nationwide threat of accelerated eutrophication to fresh water lakes and reservoirs.

OBJECTIVES

The Survey was designed to develop, in conjunction with state environmental agencies, information on nutrient sources, concentrations, and impact on selected freshwater lakes as a basis for formulating comprehensive and coordinated national, regional, and state management practices relating to point-source discharge reduction and non-point source pollution abatement in lake watersheds.

ANALYTIC APPROACH

The mathematical and statistical procedures selected for the Survey's eutrophication analysis are based on related concepts that:

a. A generalized representation or model relating sources, concentrations, and impacts can be constructed.

b. By applying measurements of relevant parameters associated with lake degradation, the generalized model can be transformed into an operational representation of a lake, its drainage basin, and related nutrients.

c. With such a transformation, an assessment of the potential for eutrophication control can be made.

LAKE ANALYSIS

In this report, the first stage of evaluation of lake and watershed data collected from the study lake and its drainage basin is documented. The report is formatted to provide state environmental agencies with specific information for basin planning [§303(e)], water quality criteria/standards review [§303(c)], clean lakes [§314(a,b)], and water quality monitoring [§106 and §305(b)] activities mandated by the Federal Water Pollution Control Act Amendments of 1972.

Beyond the single lake analysis, broader based correlations between nutrient concentrations (and loading) and trophic condition are being made to advance the rationale and data base for refinement of nutrient water quality criteria for the Nation's fresh water lakes. Likewise, multivariate evaluations for the relationships between land use, nutrient export, and trophic condition, by lake class or use, are being developed to assist in the formulation of planning guidelines and policies by EPA and to augment plans implementation by the states.

ACKNOWLEDGMENT

The staff of the National Eutrophication Survey (Office of Research & Development, U. S. Environmental Protection Agency) expresses sincere appreciation to the Illinois Environmental Protection Agency for professional involvement and to the Illinois National Guard for conducting the tributary sampling phase of the Survey.

Dr. Richard H. Briceland, Director of the Illinois Environmental Protection Agency; and Ronald M. Barganz, State Survey Coordinator, and John J. Forneris, Manager of Region III, Field Operations Section of the Division of Water Pollution Control, provided invaluable lake documentation and counsel during the Survey, reviewed the preliminary reports, and provided critiques most useful in the preparation of this Working Paper series.

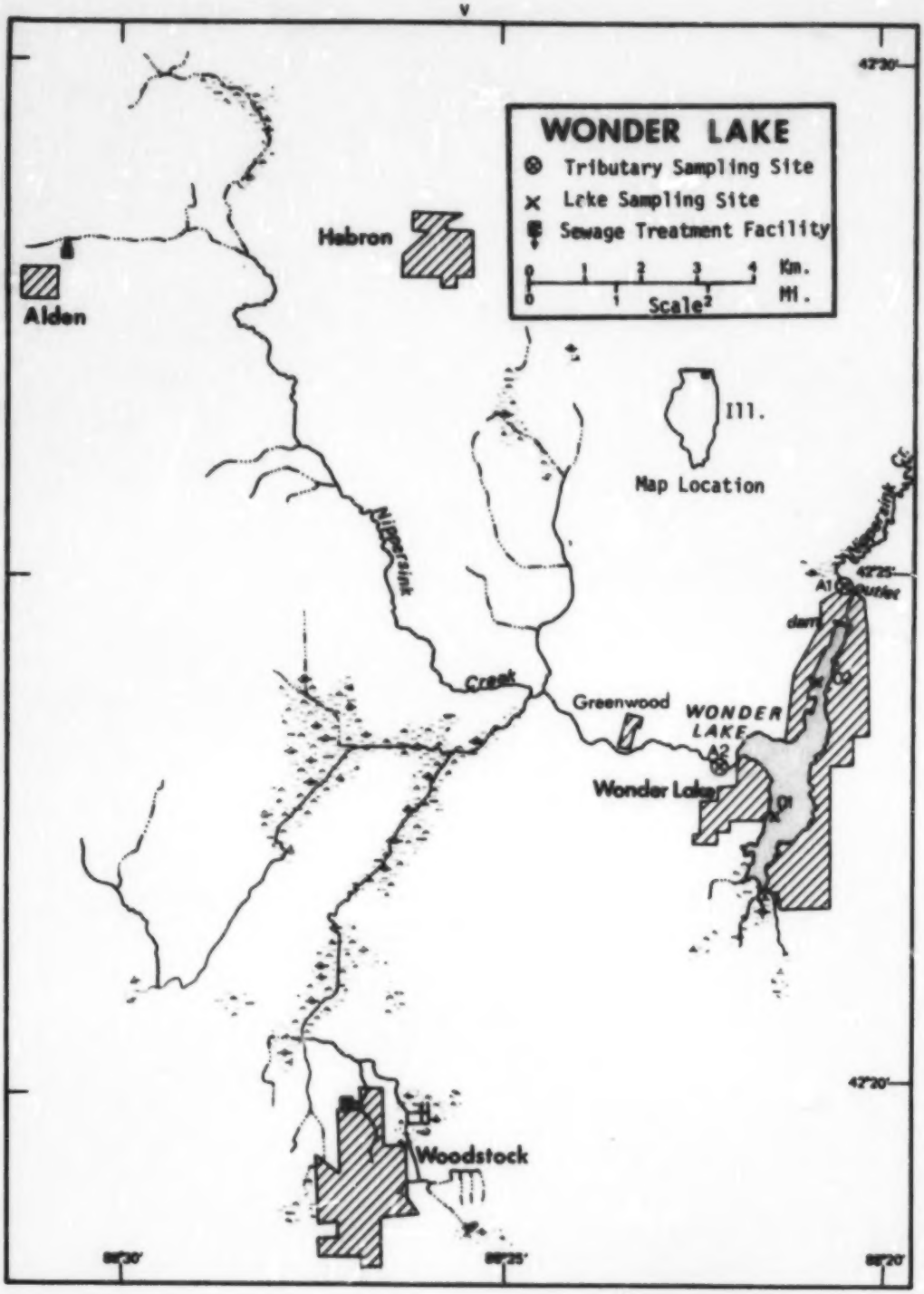
Major General Harold R. Patton, the Adjutant General of Illinois, and Project Officer Colonel Daniel L. Fane, who directed the volunteer efforts of the Illinois National Guardsmen, are also gratefully acknowledged for their assistance to the Survey.

NATIONAL EUTROPHICATION SURVEY

STUDY LAKES

STATE OF ILLINOIS

LAKE NAME	COUNTY
Baldwin	Randolph
Bloomington	McLean
Carlyle	Bond, Clinton, Fayette
Cedar	Lake
Charleston	Coles
Coffeen	Montgomery
Crab Orchard	Jackson, Williamson
Decatur	Macon
DePue	Bureau
East Loon	Lake
Fox	Lake
Grass	Lake
Highland Silver	Madison
Holiday	LaSalle
Horseshoe	Madison
Long	Lake
Lou Yaeger	Montgomery
Marie	Lake
Old Ben Mine	Franklin
Pistakee	Lake, McHenry
Raccoon	Marion
Rend	Franklin, Jefferson
Sangchris	Christian
Shelbyville	Moultrie, Shelby
Slocum	Lake
Springfield	Sangamon
Storey	Knox
Vandalia	Fayette
Vermilion	Vermilion
Wee Ma Tuk	Fulton
Wonder	McHenry


WONDER LAKE
Tributary Sampling Site
Lake Sampling Site
Sewage Treatment Facility
0 1 2 3 4 Km.
0 1 Scale² MI.
Hebron
Alden
Ill.
Map Location
Nippersink
Creek
Greenwood
WONDER LAKE
A2
Wonder Lake
Woodstock
42°30'
42°25'
42°20'
88°30'
88°25'
88°20'

WONDER LAKE

STORET NO. 1730

I. CONCLUSIONS

A. Trophic Condition:

Survey data indicate Wonder Lake is highly eutrophic. Of the 31 Illinois water bodies sampled in 1973, Wonder Lake ranked 30th in overall trophic quality when the lakes were compared using a combination of six parameters*. Twenty-six of the lakes had less median total and dissolved phosphorus, 15 had less median inorganic nitrogen, 28 had less mean chlorophyll a, and 24 had greater mean Secchi disc transparency.

Survey limnologists did not observe any nuisance conditions duirng their visits to the lake.

B. Rate-Limiting Nutrient:

The algal assay results indicate Wonder Lake was phosphorus limited at the time the assay sample was collected (05/09/73). However, the lake data indicate nitrogen limitation in August and October; i.e., the mean N/P ratios were 2/1 and 5/1, respectively, and nitrogen limitation would be expected.

C. Nutrient Controllability:

1. Point sources--The two known point sources impacting Wonder Lake contributed 71.1% of the total phosphorus load

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* See Appendix A.

reaching the lake during the sampling year. With 80% phosphorus removal instituted at the two point sources, the present loading rate of 12.39 $g/m^2/yr$ would be reduced to 5.33 $g/m^2/yr$. However, even this loading rate is over six times the rate proposed by Vollenweider (Vollenweider and Dillon, 1974) as a eutrophic rate (see page 12). Nonetheless, considering the short hydraulic retention time of 54 days, 80% or more phosphorus removal should improve the trophic condition of Wonder Lake since the lake is presently phosphorus limited part of the time.

2. Non-point sources--The estimated non-point phosphorus load of Nippersink Creek accounted for 24.0% of the total phosphorus load to the lake. Minor tributaries and immediate drainage were estimated to have contributed 3.3% of the total load.

II. LAKE AND DRAINAGE BASIN CHARACTERISTICS†

A. Lake Morphometry††:

1. Surface area: 2.95 kilometers^2.
2. Mean depth: 2.5 meters.
3. Maximum depth: unknown.
4. Volume: 7.401 x 10^6 m^3.
5. Mean hydraulic retention time: 54 days.

B. Tributary and Outlet:
(See Appendix C for flow data)

1. Tributaries -

Name	Drainage area (km^2)*	Mean flow (m^3/sec)*
Nippersink Creek	218.9	1.4
Minor tributaries & immediate drainage -	30.1	0.2
Totals	249.0	1.6

2. Outlet -

Nippersink Creek	252.0**	1.6

C. Precipitation***:

1. Year of sampling: 125.6 centimeters.
2. Mean annual: 92.2 centimeters.

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† Table of metric conversions--Appendix B.
†† Forneris, 1973.
* For limits of accuracy, see Working Paper No. 175, "...Survey Methods, 1973-1976".
** Includes area of lake.
*** See Working Paper No. 175.

III. LAKE WATER QUALITY SUMMARY

Wonder Lake was sampled three times during the open-water season of 1973 by means of a pontoon-equipped Huey helicopter. Each time, samples for physical and chemical parameters were collected from two depths at two stations on the lake (see map, page v). During each visit, a single depth-integrated (near bottom to surface) sample was composited from the stations for phytoplankton identification and enumeration; and during the first visit, a single 18.9-liter depth-integrated sample was composited for algal assays. Also each time, a depth-integrated sample was collected from each of the stations for chlorophyll a analysis. The maximum depth sampled at each station was 1.5 meters.

The lake sampling results are presented in full in Appendix D and are summarized in the following table.

A. SUMMARY OF PHYSICAL AND CHEMICAL CHARACTERISTICS FOR WONDER LAKE
STORET CODE 1750

PARAMETER	1ST SAMPLING (5/ 9/73) 2 SITES RANGE	MEAN	MEDIAN	2ND SAMPLING (8/ 7/73) 2 SITES RANGE	MEAN	MEDIAN	3RD SAMPLING (10/16/73) 2 SITES RANGE	MEAN	MEDIAN
TEMP (C)	14.5 - 14.8	14.6	14.6	25.9 - 26.5	26.3	26.3	14.1 - 15.5	14.8	14.8
DISS OXY (MG/L)	8.4 - 8.7	8.5	8.5	7.2 - 8.6	7.9	7.9	12.6 - 14.4	13.5	13.5
CNDCTVY (MCROMO)	548. - 560.	555.	560.	743. - 763.	754.	754.	510. - 533.	523.	524.
PH (STAND UNITS)	8.1 - 8.1	8.1	8.1	8.5 - 8.5	8.5	8.5	8.7 - 8.8	8.7	8.7
TOT ALK (MG/L)	240. - 250.	248.	250.	330. - 336.	334.	334.	234. - 244.	241.	242.
TOT P (MG/L)	0.217 - 0.323	0.260	0.250	0.518 - 0.678	0.606	0.614	0.363 - 0.477	0.423	0.420
ORTHO P (MG/L)	0.096 - 0.103	0.099	0.099	0.357 - 0.441	0.404	0.409	0.128 - 0.143	0.134	0.132
NO2+NO3 (MG/L)	2.050 - 2.150	2.097	2.095	0.390 - 0.430	0.412	0.415	0.530 - 0.580	0.567	0.580
AMMONIA (MG/L)	0.210 - 0.240	0.230	0.23'	0.420 - 0.580	0.485	0.470	0.030 - 0.050	0.037	0.035
KJEL N (MG/L)	0.980 - 1.300	1.075	1.050	2.400 - 2.900	2.650	2.650	1.000 - 2.300	1.825	2.000
INORG N (MG/L)	2.290 - 2.360	2.327	2.330	0.810 - 1.000	0.897	0.890	0.560 - 0.630	0.605	0.615
TOTAL N (MG/L)	2.950 - 3.360	3.172	3.190	2.790 - 3.330	3.062	3.065	1.530 - 2.880	2.392	2.580
CHLRPYL A (UG/L)	20.5 - 23.7	22.1	22.1	59.7 - 91.3	75.5	75.5	185.0 - 211.0	198.0	198.0
SECCHI (METERS)	0.1 - 0.2	0.2	0.2	0.3 - 0.6	0.5	0.5	0.3 - 0.6	0.5	0.5

B. Biological characteristics:

1. Phytoplankton -

Sampling Date	Dominant Genera	Algal units per ml
05/09/73	1. Stephanodiscus sp.	979
	2. Melosira sp.	894
	3. Cryptomonas sp.	516
	4. Scenedesmus sp.	285
	5. Dinobryon sp.	274
	Other genera	1,376
	Total	4,304
08/07/73	1. Melosira sp.	3,155
	2. Stephanodiscus sp.	947
	3. Microcystis sp.	276
	4. Euglena sp.	237
	5. Glenodinium sp. and Gymnodinium sp.	237
	Other genera	1,459
	Total	6,311
10/16/73	1. Stephanodiscus sp.	4,791
	2. Cryptomonas sp.	1,060
	3. Flagellates	424
	4. Melosira sp.	339
	5. Schroederia sp.	229
	Other genera	705
	Total	7,548

2. Chlorophyll a -

Sampling Date	Station Number	Chlorophyll a (µg/l)
05/09/73	01	20.5
	02	23.7
08/07/73	01	59.7
	02	91.3
10/16/73	01	185.0
	02	211.0

C. Limiting Nutrient Study:

1. Autoclaved, filtered, and nutrient spiked -

Spike (mg/l)	Ortho P Conc. (mg/l)	Inorganic N Conc. (mg/l)	Maximum yield (mg/l-dry wt.)
Control	0.040	1.835	15.4
0.050 P	0.090	1.835	43.4
0.050 P + 1.0 N	0.090	2.835	42.3
1.0 N	0.040	2.835	14.2

2. Discussion -

The control yield of the assay alga, Selenastrum capricornutum, indicates that the potential primary productivity of Wonder Lake was high at the time the assay sample was collected (05/09/73). Also, the results indicate the lake was phosphorus limited at that time. Note that the addition of orthophosphorus resulted in a yield much greater than the control yield, but the addition of only nitrogen did not result in an increased yield.

However, the lake data indicate nitrogen limitation in August and October; i.e., the mean inorganic nitrogen/orthophosphorus ratios were 2/1 and 5/1, respectively, and nitrogen limitation would be expected.

IV. NUTRIENT LOADINGS
(See Appendix E for data)

For the determination of nutrient loadings, the Illinois National Guard collected monthly near-surface grab samples from each of the tributary sites indicated on the map (page v), except for the high runoff months of February and March when two samples were collected. Sampling was begun in June, 1973, and was completed in May, 1974.

Through an interagency agreement, stream flow estimates for the year of sampling and a "normalized" or average year were provided by the Illinois District Office of the U.S. Geological Survey for the tributary sites nearest the lake.

In this report, nutrient loads for station A-1 were determined by using a modification of a U.S. Geological Survey computer program for calculating stream loadings*. However, the calculated nutrient loads in Nippersink Creek at station A-2 were less than the nutrient loads attributed to upstream point sources. Assuming that all the phosphorus from all sources eventually reach the lake, the nutrient export loads in Nippersink Creek at station 33A-1 of the Fox Chain of Lakes** were used as background loads in the creek in this report.

Nutrient loads for unsampled "minor tributaries and immediate drainage" ("ZZ" of U.S.G.S.) were estimated using the nutrient loads, in $kg/km^2/year$, in Nippersink Creek, tributary to the Fox Chain of Lakes, at station 33A-1 and multiplying by the ZZ area in km^2.

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* See Working Paper No. 175.
** Working Paper No. 305.

The operator of the Woodstock wastewater treatment plant provided monthly effluent samples and corresponding flow data. The town of Alden did not participate in the Survey, and nutrient loads were estimated at 1.134 kg P and 3.401 kg N/capita/year.

The Woodstock Die Casting Company discharges to Nippersink Creek, but this discharge is not believed to be significant in terms of primary nutrients.

A. Waste Sources:

1. Known municipal* -

Name	Pop. Served	Treatment	Mean Flow (m^3/d)	Receiving Water
Alden	400	act. sludge	151.4**	Nippersink Creek
Woodstock	10,010	act. sludge + ponds	8,955.6	Nippersink Creek

2. Known industrial* -

Name	Product	Treatment	Mean Flow (m^3/d)	Receiving Water
Woodstock Die Casting Company	plating	chemicals + sand fltr.	?	Nippersink Creek

* Anonymous, 1972; Barganz, 1975.
** Estimated at 0.3785 m^3/capita/day.

B. Annual Total Phosphorus Loading - Average Year:

1. Inputs -

Source	kg P/ yr	% of total
a. Tributaries (non-point load) -		
Nippersink Creek	8,755	24.0
b. Minor tributaries & immediate drainage (non-point load) -	1,205	3.3
c. Known municipal STP's -		
Woodstock	25,530	69.9
Alden	455	1.2
d. Septic tanks* -	545	1.5
e. Known industrial -		
Woodstock Die Casting Co.	?	-
f. Direct precipitation** -	50	0.1
Total	36,540	100.0

2. Outputs -

Lake outlet - Nippersink Creek 15,980

3. Net annual P accumulation - 20,560 kg.

* Estimate based on population of the Village of Wonder Lake (4,806); see Working Paper No. 175.
** See Working Paper No. 175.

C. Annual Total Nitrogen Loading - Average Year:

1. Inputs -

Source	kg N/ yr	% of total
a. Tributaries (non-point load) -		
Nippersink Creek	149,945	61.3
b. Minor tributaries & immediate drainage (non-point load) -	20,620	8.4
c. Known municipal STP's -		
Woodstock	49,075	20.1
Alden	1,360	0.6
d. Septic tanks* -	20,490	8.4
e. Known industrial -		
Woodstock Die Casting Co.	?	-
f. Direct precipitation** -	3,185	1.2
Total	244,675	100.0

2. Outputs -

Lake outlet - Nippersink Creek 144,795

3. Net annual N accumulation - 99,880 kg.

* Estimate based on population of the Village of Wonder Lake (4,806); see Working Paper No. 175.
** See Working Paper No. 175.

D. Mean Annual Non-point Nutrient Export by Subdrainage Area:

Tributary	kg P/km²/yr	kg N/km²/yr
Nippersink Creek (at station 33A-1, Fox Chain of Lakes)	40	685

E. Yearly Loading Rates:

In the following table, the existing phosphorus loading rates are compared to those proposed by Vollenweider (Vollenweider and Dillon, 1974). Essentially, his "dangerous" rate is the rate at which the receiving water would become eutrophic or remain eutrophic; his "permissible" rate is that which would result in the receiving water remaining oligotrophic or becoming oligotrophic if morphometry permitted. A mesotrophic rate would be considered one between "dangerous" and "permissible".

Note that Vollenweider's model may not be applicable to water bodies with short hydraulic retention times.

	Total Phosphorus		Total Nitrogen	
	Total	Accumulated	Total	Accumulated
grams/m²/yr	12.39	6.97	82.9	33.9

Vollenweider loading rates for phosphorus (g/m²/yr) based on mean depth and mean hydraulic retention time of Wonder Lake:

"Dangerous" (eutrophic rate)	0.80
"Permissible" (oligotrophic rate)	0.40

V. LITERATURE REVIEWED

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Barganz, Ronald M., 1975. Personal communication (Alden STP). IL Env. Prot. Agency, Springfield.

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Vollenweider, R. A., and P. J. Dillon, 1974. The application of the phosphorus loading concept to eutrophication research. Natl. Res. Council of Canada Publ. No. 13690, Canada Centre for Inland Waters, Burlington, Ontario.

VI. APPENDICES

APPENDIX A

LAKE RANKINGS

LAKE DATA TO BE USED IN RANKINGS

LAKE CODE	LAKE NAME	MEDIAN TOTAL P	MEDIAN INORG N	500-MEAN SEC	MEAN CHLORA	15-MIN DU	MEDIAN DISS ORTHO P
1703	LAKE BLOOMINGTON	0.050	5.730	464.667	26.200	14.000	0.020
1706	LAKE CARLYLE	0.004	1.270	477.009	17.367	11.090	0.032
1708	LAKE CHARLESTON	0.160	4.600	490.667	12.000	6.400	0.005
1711	COFFEEN LAKE	0.032	0.260	456.222	7.700	14.900	0.012
1712	CRAB ORCHARD LAKE	0.082	0.290	482.222	59.067	13.000	0.013
1714	LAKE DECATUR	0.129	3.750	479.571	43.000	14.500	0.062
1725	LONG LAKE	0.704	1.190	482.667	49.333	8.600	0.390
1726	LAKE LAU YAEGER	0.186	1.600	489.583	18.662	11.400	0.076
1727	LAKE MARIE	0.090	0.370	467.667	30.533	14.700	0.057
1733	PISTAKEE LAKE	0.203	0.370	485.667	75.067	7.000	0.062
1738	REND LAKE	0.071	0.210	471.500	23.533	12.700	0.012
1739	LAKE SHELBYVILLE	0.092	3.290	481.333	17.161	14.000	0.019
1740	SILVER LAKE (HIGHLAND)	0.224	0.970	489.500	5.022	14.000	0.057
1742	LAKE SPRINGFIELD	0.106	3.205	483.305	13.013	10.000	0.059
1748	VERMILION LAKE	0.109	4.695	481.500	31.150	14.200	0.050
1750	WOOWER LAKE	0.424	0.090	486.003	98.533	7.000	0.132
1751	LAKE STORY	0.072	2.510	459.333	17.250	14.000	0.021
1752	DEPUE LAKE	0.430	4.850	499.000	58.033	7.600	0.276
1753	LAKE SANGCHRIS	0.050	1.970	475.417	19.242	14.500	0.009
1754	LAKE HOLIDAY	0.167	3.135	485.167	51.217	7.200	0.046
1755	FOX LAKE	0.219	0.375	486.167	63.850	9.000	0.063
1756	CRABO LAKE	0.301	0.020	481.000	83.500	5.900	0.093
1757	EAST LOOM LAKE	0.070	0.120	458.000	22.300	14.900	0.014
1758	SLOCUM LAKE	0.065	0.200	467.333	221.100	5.000	0.362
1759	CEDAR LAKE	0.029	0.170	480.333	5.767	12.000	0.013
1761	LAKE MENATUK	0.060	1.770	486.333	7.967	14.500	0.031
1762	RACCOON LAKE	0.104	0.310	484.333	14.217	13.000	0.020
1763	TAMARON LAKE	0.046	0.148	461.167	11.331	13.200	0.007

15A

LAKE DATA TO BE USED IN RANKINGS

LAKE CODE	LAKE NAME	MEDIAN TOTAL P	MEDIAN INORG N	500-MEAN SEC	MEAN CHLORA	15-MIN DO	MEDIAN DISS ORTHO P
1764	LAKE VANDALIA	0.116	0.480	478.111	11.278	14.800	0.023
1765	OLD BEN MINE RESERVOIR	0.930	0.205	478.333	31.433	11.200	0.575
1766	HORSESHOE LAKE	0.127	0.705	482.833	182.250	6.800	0.018

PERCENT OF LAKES WITH HIGHER VALUES (NUMBER OF LAKES WITH HIGHER VALUES)

LAKE CODE	LAKE NAME	MEDIAN TOTAL P	MEDIAN INORG N	500-MEAN SEC	MEAN CHLORA	15-MIN DO	MEDIAN DISS ORTHO P	INDEX NU
1703	LAKE BLOOMINGTON	88 (26)	0 (0)	80 (24)	47 (14)	13 (2)	68 (20)	296
1706	LAKE CARLYLE	63 (19)	40 (12)	63 (19)	63 (19)	63 (19)	53 (16)	345
1708	LAKE CHARLESTON	37 (11)	7 (2)	0 (0)	77 (23)	77 (23)	27 (8)	225
1711	COFFEEN LAKE	97 (29)	77 (23)	93 (28)	93 (28)	2 (0)	92 (27)	454
1712	CRAB ORCHARD LAKE	67 (20)	90 (27)	43 (13)	20 (6)	42 (12)	85 (25)	347
1714	LAKE DECATUR	40 (12)	13 (4)	53 (16)	33 (10)	30 (8)	32 (9)	201
1725	LONG LAKE	7 (2)	43 (13)	40 (12)	30 (9)	72 (21)	3 (1)	195
1726	LAKE LOU YAEGER	30 (9)	37 (11)	7 (2)	87 (26)	57 (17)	23 (7)	241
1727	LAKE MARIE	60 (18)	68 (20)	73 (22)	37 (11)	23 (7)	42 (12)	303
1733	PISTAKEE LAKE	27 (8)	68 (20)	23 (7)	13 (4)	90 (27)	32 (9)	253
1735	REND LAKE	77 (23)	80 (24)	70 (21)	50 (15)	53 (16)	92 (27)	422
1739	LAKE SHELBYVILLE	83 (25)	17 (5)	83 (25)	70 (21)	13 (2)	73 (22)	339
1740	SILVER LAKE (HIGHLAND)	20 (6)	47 (14)	10 (3)	97 (29)	13 (2)	42 (12)	229
1742	LAKE SPRINGFIELD	53 (16)	20 (6)	33 (10)	73 (22)	67 (20)	37 (11)	283
1748	VERMILION LAKE	50 (15)	3 (1)	47 (14)	43 (13)	37 (11)	47 (14)	227
1750	WONDER LAKE	13 (4)	50 (15)	20 (6)	7 (2)	80 (24)	13 (4)	183
1751	LAKE STORY	73 (22)	27 (8)	90 (27)	67 (20)	13 (2)	63 (19)	333
1752	DEPUE LAKE	10 (3)	10 (3)	3 (1)	23 (7)	83 (25)	10 (3)	139
1753	LAKE SANGCHRIS	88 (26)	30 (9)	67 (20)	57 (17)	30 (8)	97 (29)	369
1754	LAKE HOLIDAY	33 (10)	23 (7)	27 (8)	27 (8)	87 (26)	50 (15)	247
1755	FOX LAKE	23 (7)	63 (19)	17 (5)	17 (5)	72 (21)	20 (6)	212
1756	GRASS LAKE	17 (5)	53 (16)	50 (15)	10 (3)	97 (29)	17 (5)	244
1757	EAST LOOM LAKE	70 (21)	100 (30)	97 (29)	53 (16)	2 (0)	77 (23)	399
1758	SLOCUM LAKE	3 (1)	87 (26)	13 (4)	0 (0)	100 (30)	7 (2)	210
1759	CEDAR LAKE	100 (30)	93 (28)	100 (30)	100 (30)	50 (15)	85 (25)	526
1761	LAKE MENSTUK	80 (24)	33 (10)	77 (23)	90 (27)	30 (8)	57 (17)	367
1762	RACCOON LAKE	57 (17)	73 (22)	30 (9)	60 (18)	42 (12)	68 (20)	330
1763	BALDWIN LAKE	93 (28)	97 (29)	87 (26)	80 (24)	47 (14)	100 (30)	504

PERCENT OF LAKES WITH HIGHER VALUES (NUMBER OF LAKES WITH HIGHER VALUES)

LAKE CODE	LAKE NAME	MEDIAN TOTAL P	MEDIAN INORG N	500- MEAN SEC	MEAN CHLORA	15- MIN DO	MEDIAN DISS ORTHO P	INDEX NO
1764	LAKE VANDALIA	47 (14)	60 (18)	60 (18)	83 (25)	13 (2)	60 (18)	323
1765	OLD BEN MINE RESERVOIR	0 (0)	83 (25)	57 (17)	40 (12)	60 (18)	0 (0)	240
1766	HORSESHOE LAKE	43 (13)	57 (17)	37 (11)	3 (1)	93 (28)	80 (24)	313

LAKES RANKED BY INDEX NOS.

RANK	LAKE CODE	LAKE NAME	INDEX NO
1	1759	CEDAR LAKE	528
2	1763	BALDWIN LAKE	504
3	1711	COFFEEN LAKE	454
4	1735	REND LAKE	422
5	1757	EAST LOON LAKE	399
6	1753	LAKE SANGCHRIS	369
7	1761	LAKE WENATUK	367
8	1712	CRAB ORCHARD LAKE	347
9	1706	LAKE CARLYLE	345
10	1739	LAKE SHELBYVILLE	339
11	1751	LAKE STORY	333
12	1762	RACCOON LAKE	330
13	1764	LAKE VANDALIA	323
14	1766	HORSESHOE LAKE	313
15	1727	LAKE MARIE	303
16	1703	LAKE BLOOMINGTON	296
17	1742	LAKE SPRINGFIELD	283
18	1733	PISTAKEE LAKE	253
19	1754	LAKE HOLIDAY	247
20	1756	GRASS LAKE	244
21	1726	LAKE LOU YAEGER	241
22	1765	OLD BEN MINE RESERVOIR	240
23	1740	SILVER LAKE (HIGHLAND)	229
24	1748	VERMILION LAKE	227
25	1708	LAKE CHARLESTON	225
26	1755	FOX LAKE	212
27	1758	SLOCUM LAKE	210
28	1714	LAKE DECATUR	201

LAKES RANKED BY INDEX NOS.

RANK	LAKE CODE	LAKE NAME	INDEX NO
29	1725	LONG LAKE	195
30	1750	WONDER LAKE	183
31	1752	DEPUE LAKE	139

APPENDIX B

CONVERSIONS FACTORS

CONVERSION FACTORS

Hectares x 2.471 = acres

Kilometers x 0.6214 = miles

Meters x 3.281 = feet

Cubic meters x 8.107×10^{-4} = acre/feet

Square kilometers x 0.3861 = square miles

Cubic meters/sec x 35.315 = cubic feet/sec

Centimeters x 0.3937 = inches

Kilograms x 2.205 = pounds

Kilograms/square kilometer x 5.711 = lbs/square mile

APPENDIX C

TRIBUTARY FLOW DATA

TRIBUTARY FLOW INFORMATION FOR ILLINOIS 10/23/75

LAKE CODE 1750 WONDER LAKE

TOTAL DRAINAGE AREA OF LAKE(SQ KM) 252.0

TRIBUTARY	SUB-DRAINAGE AREA(SQ KM)	NORMALIZED FLOWS(CMS) JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	MEAN
1750A1	252.0	1.69	2.47	3.09	3.[illegible]8	2.52	2.09	1.28	0.67	0.48	0.56	0.78	0.91	1.64
1750A2	218.9	1.46	2.17	2.71	2.[illegible]1	2.20	1.83	1.12	0.58	0.42	0.47	0.67	0.80	1.43
1750ZZ	31.1	0.21	0.30	0.37	0.4[illegible]	0.31	0.26	0.16	0.08	0.06	0.07	0.10	0.12	0.20

SUMMARY

TOTAL DRAINAGE AREA OF LAKE = 252.0 TOTAL FLOW IN = 19.71
SUM OF SUB-DRAINAGE AREAS = 249.9 TOTAL FLOW OUT = 19.71

MEAN MONTHLY FLOWS AND DAILY FLOWS(CMS)

TRIBUTARY	MONTH	YEAR	MEAN FLOW	DAY	FLOW	DAY	FLOW	DAY	FLOW
1750A1	6	73	3.65	2	3.34				
	7	73	1.93	7	2.44				
	8	73	1.42	25	2.01				
	9	73	1.59	22	1.95				
	10	73	3.03	13	3.96				
	11	73	2.38	3	2.12				
	12	73	3.77	1	2.72				
	1	74	4.73	6	1.76				
	2	74	6.20	2	10.82	16	3.86		
	3	74	8.38	2	10.31	16	6.17		
	4	74	6.06	6	4.96				
	5	74	7.42	4	21.44				
1750A2	6	73	3.20	2	2.92				
	7	73	1.70	7	2.12				
	8	73	1.22	25	1.76				
	9	73	1.39	22	1.70				
	10	73	2.63	13	3.45				
	11	73	2.07	3	1.84				
	12	73	3.28	1	2.38				
	1	74	4.13	6	1.53				
	2	74	5.44	2	9.49	16	2.66		
	3	74	7.31	2	9.86	16	5.44		
	4	74	5.30	6	4.33				
	5	74	6.51	4	18.88				
1750ZZ	6	73	0.48	2	0.42				
	7	73	0.23	7	0.31				
	8	73	0.20	25	0.25				
	9	73	0.29	22	0.25				
	10	73	0.49	13	0.51				
	11	73	0.31	3	0.28				
	12	73	0.48	1	0.34				
	1	74	1.25	6	0.37				
	2	74	0.76	2	1.33	16	0.48		
	3	74	0.99	2	1.25	16	0.74		
	4	74	0.76	6	0.62				
	5	74	0.91	4	2.66				

APPENDIX D

PHYSICAL and CHEMICAL DATA

STORET RETRIEVAL DATE 75/10/23

175061
42 24 00.0 088 20 40.0
WONDER LAKE
17111 ILLINOIS

11EPALES 2111202
3 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00610 NH3-N TOTAL MG/L	00625 TOT KJEL N MG/L	00630 NO2&NO3 N-TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P
73/05/09	15 45	0000	14.5		8	560	8.10	250	0.210	1.100	2.150	0.095
	15 45	0005	14.5	8.4		560	8.10	250	0.230	1.000	2.130	0.098
73/08/07	15 20	0000	26.3		24	747	8.50	334	0.420	2.400	0.390	0.379
	15 20	0005	25.9	7.2		743	8.50	330	0.440	2.600	0.410	0.357
73/10/16	16 19	0000	15.5		23	531	8.80	234	0.050	2.100	0.500	0.129
	16 19	0004	15.5	14.4		533	8.70	244	0.030	1.900	0.380	0.120

DATE FROM TO	TIME OF DAY	DEPTH FEET	00665 PHOS-TOT MG/L P	32217 CHLRPHYL A UG/L
73/05/09	15 45	0000	0.234	20.5
	15 45	0005	0.217	
73/08/07	15 20	0000	0.518	59.7
	15 20	0005	0.560	
73/10/16	16 19	0000	0.363	185.0
	16 19	0004	0.388	

STORET RETRIEVAL DATE 75/10/23

175002
42 22 28.0 088 21 29.0
WONDER LAKE
17111 ILLINOIS

11EPALES
3

2111202
0006 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00610 NH3-N TOTAL MG/L	00625 TOT KJEL N MG/L	00630 NO2&NO3 N-TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P
73/05/09	16 00	0000	14.8		4	540	8.10	250	0.240	0.900	2.050	0.103
	16 00	0004	14.8	8.7		560	8.10	240	0.240	1.300	2.060	0.102
73/08/07	15 35	0000	26.5		12	763	8.50	334	0.580	2.700	0.420	0.441
	15 35	0005	26.4	8.6		761	8.50	336	0.500	2.900	0.430	0.440
73/10/16	16 22	0000	14.2		13	510	8.70	242	0.040	2.300	0.580	0.143
	16 22	0003	14.1	12.6		516	8.70	242	0.030	1.000	0.530	0.135

DATE FROM TO	TIME OF DAY	DEPTH FEET	00665 PHOS-TOT MG/L P	32217 CHLRPHYL A UG/L
73/05/09	16 00	0000	0.323	23.7
	16 00	0004	0.266	
73/08/07	15 35	0000	0.678	91.3
	15 35	0005	0.668	
73/10/16	16 22	0000	0.465	211.0
	16 22	0003	0.477	

APPENDIX E

TRIBUTARY and WASTEWATER TREATMENT PLANT DATA

STORET RETRIEVAL DATE 75/10/23

1750A1
42 24 50.0 088 20 35.0
NIPPERSINK CREEK
17183 15 MCHENRY
O/WONDER LAKE
ST RD 13 BRDG .5 MI BELO DAM
11EPALES 2111204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
73/06/02	09 40		0.138	2.520	0.046	0.033	0.165
73/07/07	08 45		0.336	4.200	0.220	0.220	0.360
73/08/25	17 00		0.330	2.900	0.420	0.470	0.573
73/09/22	09 15		0.130	1.680	0.072	0.200	0.350
73/10/13	08 45		0.690	1.800	0.260	0.198	0.345
73/11/03	09 00		0.320	1.450	0.075	0.092	0.390
73/12/01	08 49		0.672	2.000	0.036	0.048	0.360
74/01/06	10 15		2.520	0.800	0.096	0.104	0.160
74/02/02	09 01		3.500	1.300	0.140	0.140	0.190
74/02/16	09 40		2.800	0.900	0.195	0.135	0.190
74/03/02	08 50		3.080	1.000	0.115	0.095	0.185
74/03/16	09 00		2.050	1.000	0.050	0.120	0.185
74/04/06	09 00		1.320	2.000	0.030	0.025	0.155
74/05/04	19 00		1.360	0.100K	0.060	0.065	0.230

K VALUE KNOWN TO BE
LESS THAN INDICATED

STORET RETRIEVAL DATE 75/10/23

1750A2
42 23 15.0 088 22 15.0
NIPPERSINK CREEK
17 15 MCHENRY
I/WONDER LAKE
THOMPSON RD BRDG W SIDE OF LAKE
11EPALES 2111204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
73/06/02	09 25		2.300	1.980	0.085	0.240	0.360
73/07/07	08 25		1.860	1.150	0.029	0.300	0.390
73/08/25	16 20		1.800	0.690	0.042	0.180	0.370
73/09/22	08 45		1.260	1.900	0.138	0.580	0.990
73/10/13	08 30		1.340	2.100	0.072	0.410	0.650
73/11/03	08 30		1.500	0.950	0.032	0.390	0.630
73/12/01	08 30		2.800	0.800	0.028	0.168	0.375
74/01/06	10 00		2.800	0.800	0.192	0.300	0.390
74/02/02	08 45		4.000	0.700	0.115	0.130	0.190
74/02/16	09 12		2.640	0.900	0.210	0.220	0.300
74/03/02	08 30		3.200	2.150	0.115	0.120	0.260
74/03/16	08 50		4.480	1.300	0.175	0.145	0.260
74/04/06	08 30		2.600	1.400	0.115	0.125	0.190
74/05/04	16 35		2.200	0.500	0.090	0.170	0.330

STORET RETRIEVAL DATE 75/10/23

1750AA AS1750AA P010000 1
42 19 34.0 088 27 25.0
WOODSTOCK STP
17183 7.5 WOODSTOCK
T/WONDER LAKE
NIPPERSINK CREEK
11EPALES 2141204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P	50051 FLOW RATE INST MGD	50053 CONDUIT FLOW-MGD MONTHLY
73/07/18 CP(T)- 73/07/18	12 00 24 00		0.200	17.600	2.100	5.500	8.300	1.700	1.650
73/08/15 CP(T)- 73/08/15	12 00 24 00		0.200	22.000	1.700	2.600		1.900	1.340
73/09/19 CP(T)- 73/09/19	12 00 24 00		0.100	15.000	2.800	2.100	12.000	2.000	1.700
73/10/24 CP(T)- 73/10/24	12 00 24 00		0.170	21.000	2.800	4.100	8.100	2.100	2.200
73/11/20 CP(T)- 73/11/20	12 00 24 00		0.200	21.000	4.200	1.760	7.200	2.200	2.000
73/12/19 CP(T)- 73/12/19	12 00 24 00		0.000	17.500	2.500	4.000	8.150	2.300	2.400
74/01/16 CP(T)- 74/01/16	12 00 24 00		0.320	19.000	0.084	5.040	8.500	2.200	2.200
74/02/20 CP(T)- 74/02/20	12 00 24 00		0.120	11.000	0.230	3.400	6.150	3.100	2.800
74/03/20 CP(T)- 74/03/20	12 00 24 00		0.320	9.700	0.310	3.900	6.950	3.200	3.900
74/04/24 CP(T)- 74/04/24	12 00 24 00		1.240	8.400	0.050K	2.900	5.900	4.000	3.300
74/05/15 CP(T)- 74/05/15	12 00 24 00		1.240	9.000	0.190	3.300	5.900	1.800	1.900
74/06/19 CP(T)- 74/06/19	12 00 24 00		0.084	14.000	0.415	1.830	7.800	2.900	3.000

K VALUE KNOWN TO BE
LESS THAN INDICATED